

Partnership for Science & Engineering Practices

Protocol for Unit Enhancement of Engineering Design Grades 6-8

Part 1 Overview of Engineering Design in NGSS

Read the text below as a reminder of Engineering Design in grades 6-8.

Also examine the way that Engineering Design is present in the NGSS performance expectations.

Important Terminology and Text from Appendix I of NGSS

Technology: *we broadly use the term “technology” to include all types of human-made systems and processes—not in the limited sense often used in schools that equates technology with modern computational and communications devices. Technologies result when engineers apply their understanding of the natural world and of human behavior to design ways to satisfy human needs and wants.*

Engineering: *We use the term “engineering” in a very broad sense to mean any engagement in a systematic practice of design to achieve solutions to particular human problems.*

Science: *is generally taken to mean the traditional natural sciences: physics, chemistry, biology, and (more recently) earth, space, and environmental sciences*

3 Components of Engineering Design:

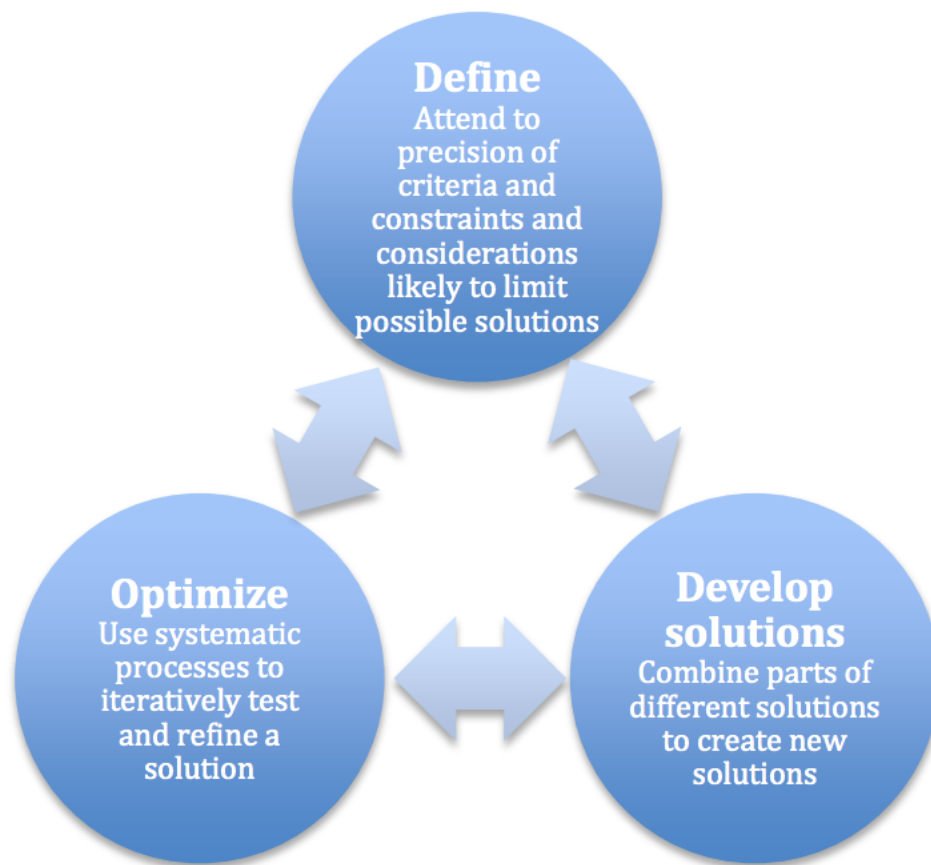
A. **Defining and delimiting engineering problems** involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits.

B. **Designing solutions to engineering problems** begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem.

C. **Optimizing the design solution** involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important.

Grades 6-8

At the middle school level, students learn to sharpen the focus of problems by precisely specifying criteria and constraints of successful solutions, taking into account not only what needs the problem is intended to meet, but also the larger context within which the problem is defined, including limits to possible solutions. Students can identify elements of different solutions and combine them to create new solutions. Students at this level are expected to use systematic methods to compare different solutions to see which best meet criteria and constraints, and to test and revise solutions a number of times in order to arrive at an optimal design.



Engineering Design Content 6-8 (ETS)

___ **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

___ **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

___ **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

NGSS Performance Expectations with Engineering connections

(These are here as a reference so you can see how some NGSS Performance Expectations may contain integrated engineering practices)

____ MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

____ MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

____ MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

____ MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Use the questions below to guide your thinking about how to effectively integrate the teaching of **Engineering Design** into your instructional materials.

Part 2. Identify the High Leverage Lesson	Facilitator NOTES
<p>Step 1: Examining your instructional material- identify the authentic opportunities for engaging in Engineering Design.</p> <p>Is there an existing Engineering task? (application task)</p> <p>If so, how can you make the existing opportunity intentional and connect it to the Engineering Design process in the NGSS?</p> <p>Is there an opportunity to add a new Engineering task?</p>	<p>Invite the STEM Professional to discuss:</p> <ul style="list-style-type: none">• the important science concepts in the identified activities• how explanation and argumentation present themselves in the "science world" <p>A starting place has already been provided for each kit. Start in these places and confirm whether an opportunity is present.</p>
<p>Step 2: Identify Science Concept</p> <p>Identify the science concepts (WA Science Standards) that students will use to engage with the Engineering task.</p>	

Part 3. Clarify the Engineering Task	
<p>Step 1: Define the Problem</p> <p>MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.</p> <p>What is the problem or challenge that will guide the Engineering Design?</p> <ul style="list-style-type: none"> · How can you make the problem more authentic? - How might you provide opportunities for students to define and delimit the problem? <p>Define the Constraints (Wants)</p> <ul style="list-style-type: none"> - What materials will students use? - What tools will students have? - Is there a time limit? <p>Define the Criteria (Needs)</p> <ul style="list-style-type: none"> - 	
<p>Step 2: Develop Solutions</p> <p>3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem</p> <p>What research might students need to do?</p> <p>What resources might they need?</p> <p>What solutions might students brainstorm?</p> <p>How will students decide which solutions to test?</p>	

Step 3: Optimize Solutions 3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. How will students test their solution? What opportunities will students have to improve their solution?	
Part 4. Determine the Assessment Task	
Step 1: Identify Assessment Target What part(s) of Engineering Design will you assess?	
Step 2: Evidence of Learning What evidence of student learning will you collect? (examples)	
Step 3: Success Criteria What criteria will you use to assess the learning? See list of possible Engineering Design criteria	
Step 4: Supports What scaffolds and supporting documents might students need?	
Part 5: Plan the Learning Sequence	
Step 1: Identify the Learning Sequence Use some of the strategies below to create a Learning Sequence. How will you: <ul style="list-style-type: none"> Introduce the Engineering Design Process 	

<ul style="list-style-type: none"> • Provide a rationale for engineering • Connect to authentic everyday examples of engineering • Provide feedback to students on their solutions 	
Step 2: Identify Tools and Strategies What strategies and activities might you use to intentionally teach students about Engineering Design so they will be successful on the Assessment Task in Part 4?	
Step 3: Supporting All Learners How can we tailor instruction to students who may have special needs, interests, and abilities? <i>(Engineering can create strong engagement that is particularly important for students who have traditionally not considered science as a possible career choice, including females and students from multiple languages and cultures in this global community)</i>	
Step 5: Additional Notes and Resources What additional information do you want to make sure and remember when you are ready to teach these lessons? What other resources might be useful for supporting teachers and/or learners during these lessons?	